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Subsurface Views

Sensors & Software Inc.

GPR applications

Water, Water Everywhere?

Exploration personnel at Agnico-Eagle Mines in Nunavut, Canada have found a unique use for the IceMap GPR system: finding water in liquid form in the winter. Water is a critical element used in drilling exploration holes to delineate ore bodies. In a land filled with thousands of lakes, water is a rare and valuable commodity when temperatures are -50^{0} C and most lakes are frozen right to the bottom.

Before IceMap, drillers augered holes randomly. Drilling a 2 meter hole could take up to an hour and would require substantial physical effort, especially in extremely cold temperatures. If the ice was frozen to the bottom of the lake and no water was encountered, they had no choice but to try again and again until they succeeded.

Now, with the IceMap system, operators can easily tell if and where water exists under the ice, even just a few inches.

The figure on page 2 shows IceMap data when the ice is frozen to the bottom of the lake. The weak reflection from the bottom of the ice is a result of the low dielectric contrast between the ice (K=3.2) and lake bottom sediments (K=5).

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Introducing Noggin 100

The Noggin family frequency range now extends down to 100 MHz! This exciting development is all the more significant when the Noggin 100 is placed into context with the Noggin product focus - GPR systems designed to make using GPR simple and easy; full GPR functionality contained in a 'monolithic' package.

Noggin GPRs are best understood when compared to other GPR systems. GPR systems require several elements to make a GPR measurement. Key components are timing & control, transmitting electronics, transmitting antenna, receiving antenna, and receiving electronics.

In addition, auxiliary components like carts, handles and odometer, plus power supply are needed for a particular deployment configuration. In early GPR systems, these elements were individual components that the operator had to assemble and interconnect.

While flexible and versatile, the complexity and set-up time required often precluded efficient operation by novice users.

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***Noggin 100** A compact, low frequency member of the Noggin family.*

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Water, Water Everywhere?

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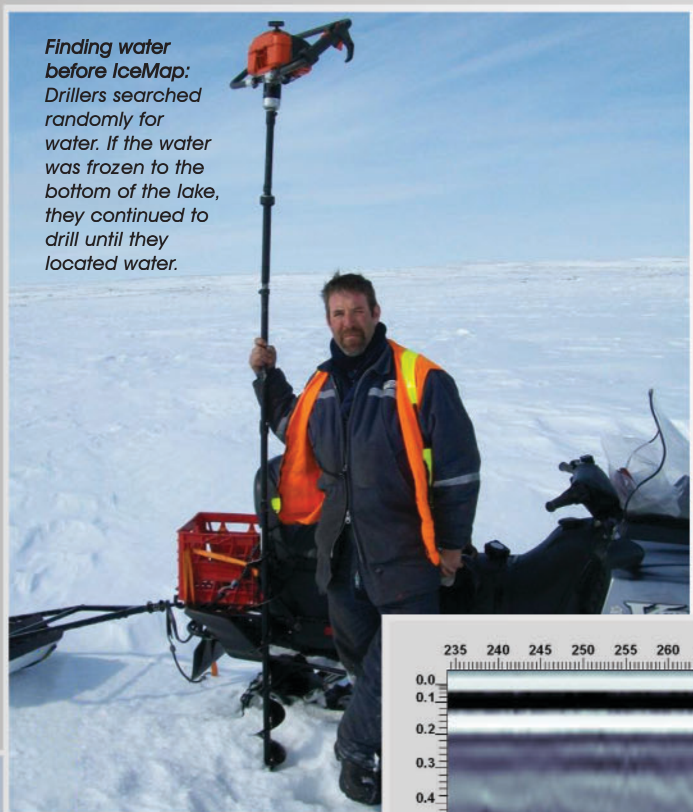
The data also shows a few areas where ice is over water. The strong reflection from the bottom of the ice is a result of the high dielectric contrast between the ice (K=3.2) and water (K=81).

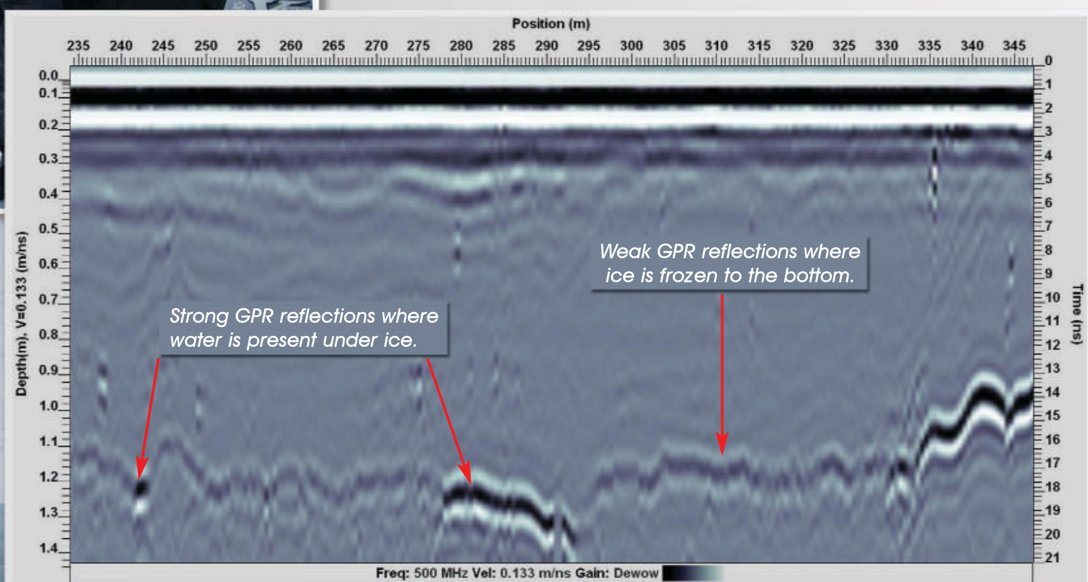
More details on reflectivity are presented in Ask-the-Expert on page 4.

Areas can now be surveyed quickly to identify the strong reflections indicative of water under ice. IceMap has increased productivity for personnel working in extreme temperatures.

Courtesy of Agnico-Eagle Mines Ltd.



Finding water before IceMap: *Drillers searched randomly for water. If the water was frozen to the bottom of the lake, they continued to drill until they located water.*



Using IceMap: *The operators can easily tell where there is water under the ice, even just a few inches.*

Noggin 100

(continued from page 1)

The Noggin family was designed to eliminate complexity, enabling users to focus on maximizing their GPR productivity. Being a knowledgeable and skilled GPR configuration specialist can be fun and challenging, but this is not always necessary or productive.

Lower frequency GPR Systems require larger antennas. Since users must transport their systems conveniently or store their system between projects, creating a compact, low frequency member of the Noggin family presented a challenge.

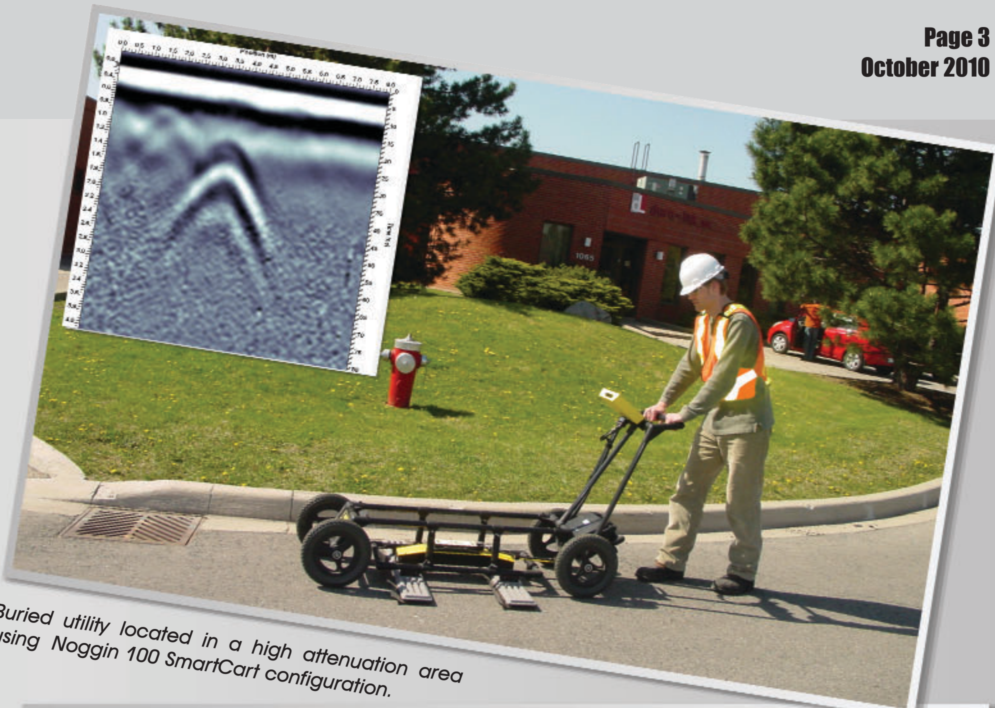
The most critical issue was size. All prior Noggins had the antennas embedded in the package. After much consideration, making the antennas detachable was considered to be consistent with the Noggin family principles.

With this barrier overcome, a prototype was quickly assembled. The bigger challenge came from meeting the demanding performance goals we set for our products. A GPR system that just works and collects data is not good enough!

After numerous iterations to achieve the desired performance, the final compact package was designed to work with the SmartCart and SmartTow deployment configurations. The last hurdle was to get the Noggin 100 system emissions in alignment with the many standards appearing around the world.

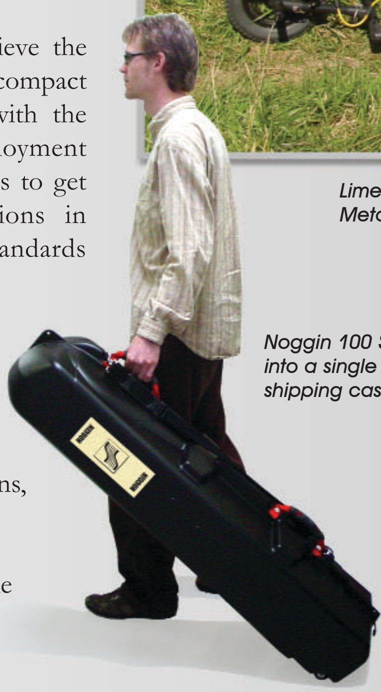
The Noggin 100 provides a compact, simple-to-use, low frequency solution for many applications including deep utility detection, geotechnical investigations, mining and archaeology.

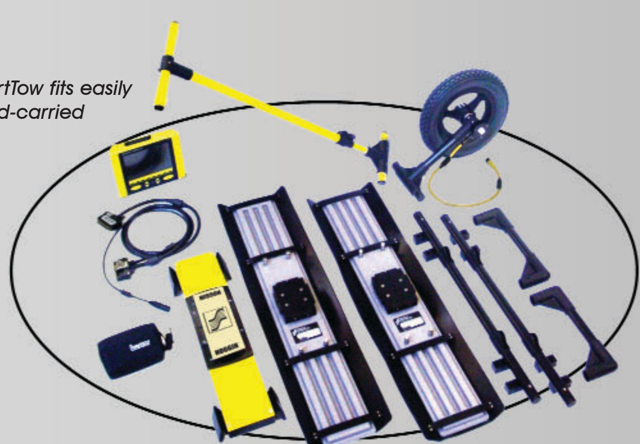
The Noggin 100 will be available worldwide at the end of 2010. ■



Buried utility located in a high attenuation area using Noggin 100 SmartCart configuration.

Limestone stratigraphy observed using Noggin 100 SmartTow configuration. Metal debris at the surface creates local ringing events.





Noggin 100 SmartTow fits easily into a single hand-carried shipping case

Technical Papers & Notes

1. **3D Polarimetric GPR Coherency Attributes and Full- Waveform Inversion of Transmission Data for Characterizing Fractured Rock,**
   GEOPHYSICS, 2009
   By: Douglas S. Sassen, Mark E. Everett, **ref 411**

2. **Voids Beneath Slabs-on-Ground- Using the impulse-response test to verify adequate slab support,**
   Concrete International, Vol. 31, No. 7, pp. 29-33, 2009
   By: Hal Amick, Blong Xiong, Ning Tang, Michael Gendreau, **ref 414**

See us at ...

SEG 2010
Denver, CO
October 17 - 20, 2010
http://www.seg.org

GSA 2010
Denver, CO
October 31 - November 3, 2010
http://www.geosociety.org/meetings/2010/

AGU 2010
San Francisco, CA
December 13 - 17, 2010
http://www.agu.org

WOC 2011
Las Vegas, NV
January 18 - 21, 2011
http://www.worldofconcrete.com

Upcoming GPR courses

One Day Noggin® Short Course
November 1, 2010
January 10, 2010

Our Noggin® short courses are offered throughout the year to anyone interested in learning more about GPR and subsurface imaging.

One Day Conquest™ Short Course
November 2, 2010
January 11, 2010

Our Conquest™ courses are offered to anyone interested in learning more about our concrete imaging instrument.

Imaging Concrete with GPR
- November 16, 2010 - Washington DC
- December 6, 2010 - Vancouver, BC

Ask-the-Expert

Why do the reflection amplitudes from boundaries differ?

The primary factor in determining reflection strength is the contrast in electrical properties. The simple normal incidence reflection coefficient is expressed as:

$$R = \frac{\sqrt{K_1} - \sqrt{K_2}}{\sqrt{K_1} + \sqrt{K_2}}$$

where K_1 is the permittivity of the material above the boundary and K_2 the permittivity of the material below the boundary. The GPR profile at the right provides an excellent illustration of this having boundaries between ice-water, ice-frozen soil and frozen soil-thawed soil being present.

Boundary	K_1	K_2	R
Ice to frozen soil	3.2	5	-0.11
Frozen to unfrozen soil	5	25	-0.38
Ice to water	3.2	81	-0.67

The relative reflection strengths based on typical permittivity values are tabulated above. ■